# Efficiency Comparison between Formal and Informal Firms – Evidence from Indian Manufacturing

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## *Abstract*

*The majority of firms in developing countries are located in the informal sector. Whether informal firms are more or less efficient than formal firms is a matter of empirical scrutiny. We investigate this by using unit record data for the informal and formal manufacturing sectors combined from four repeated cross-sections over the period 1989-2005 for the Indian economy. We apply stochastic frontier analysis to these firms to calculate absolute and relative technical efficiency, correcting for selection bias in the firm's decision to be in the informal or in the formal sector using a recent technique proposed by Greene (2010). Our selection results indicate that the likelihood of the firm being in the formal sector is positively linked to its size, less stringent labour regulation, the availability of power supply and priority sector lending to small-scale firms. After accounting for selection bias, we find that formal firms are significantly more efficient than informal firms. The results hold irrespective of their location - rural or urban. This suggests that policy-makers should relax regulations that may allow more informal sector firms to relocate to the formal sector.*

## 1. Introduction

1.1 The informal sector is a large part of economic activity in most developing economies. Typically the manufacturing sector in many developing economies has a large informal sector, where most firms reside, along a relatively small formal sector, comprising fewer firms (WTO 2009). Conventional wisdom about the informal manufacturing sector takes it that firms in this sector are generally less productive than firms in the formal manufacturing sector (Dabla-Norris *et al.* 2005). Under this view, since firms in the informal sector tend to remain small to escape the attention of government inspectors, they are not able to reap economies of scale, nor have access to credit from formal financial institutions to expand operations due to their lack of registration with government authorities. This view often underscores the policy concern about a burgeoning informal sector in the face of a shrinking or stagnant formal sector and is the basis of the oft repeated policy recommendation that entry of firms from the informal to the formal sector should be eased and that the overall policy aim with respect to the informal sector would be to reduce its size over time (World Bank 2005). However, this view is not without its critics – others argue that informal firms may well be more efficient than formal firms and this could be the reason why the informal sector does not seem to contract in size with economic growth and rapid modernization of the economy (De Soto 1989). Under this view, informal

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firms are inherently more entrepreneurial and dynamic than formal firms as they are unlikely to face the high degree of regulations faced by formal firms. Therefore, the policy prescription here would be to provide stronger support to the informal sector through access to credit and training in skills to make it grow, rather than attempt to shift firms from the informal to the formal sector.

1.2 There has been little systematic analysis of efficiency differentials between informal and formal manufacturing firms which can provide support to either of the above two propositions.[2] In great part, this has been due to lack of available data that can allow for such comparisons at the firm level. Data on output and capital stock are difficult to obtain for micro and small enterprises in the informal sector of developing countries as by definition, informal enterprises are not registered with the government and therefore, not required to submit production data to official statistical agencies. Furthermore, there are methodological problems in the comparison of efficiency between informal and formal firms which does not take into account the selection bias inherent in the choice that firms around a threshold size may prefer to be either in the informal or formal sector. Theoretical models predict that firms choose whether to be in the informal or formal sector depending on government regulations, access to formal sector credit and the ability to gain from the spillover effects of certain types of infrastructure which are mostly available to the formal sector (Dessy and Pallage 2003, Straub 2005, Ulyssea 2010, Fajnzylber *et al.* 2011). If being located in the formal sector is not random but depends on firm choice, a comparison of efficiency levels between firms in the informal and formal manufacturing sectors without addressing the endogeneity of firm location is not correct. Such a comparison would bias upwards the efficiency levels of formal manufacturing firms if these levels depended on the firm being located in the formal sector.

1.3 In this paper, we estimate the efficiency of informal and formal manufacturing firms using an unique data-set of such firms for a developing country and using stochastic frontier analysis that corrects for selection bias. We ask the question: are informal manufacturing firms less efficient than formal manufacturing firms? The country we study is India, where about 80 per cent of manufacturing employment and 17 per cent of manufacturing output is in the informal sector (NCEUS 2007), and where we have large cross-sections of firm-level data-set for both the informal and formal manufacturing sectors for four years, beginning in 1989-90 and ending in 2005-06.[3] We look at both absolute and relative efficiency, and find that formal firms are more efficient than informal firms, both for absolute and relative efficiency. Our findings support the policy concern about the high proportion of firms in the informal sector, as our results imply such a phenomenon may be one important reason for the low levels of productivity witnessed in the manufacturing sectors of developing countries.

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[2] There have been a limited number of empirical studies that have investigated whether small firms are more efficient than larger firms (see Taymaz 2005, and Yang and Chen 2009). However, these studies do not investigate the difference in efficiency between informal and formal firms.

[3] The formal sector in India is taken to be definitionally equivalent to the organized sector, which comprises firms which are registered under the Indian Factories Act of 1948. Firms have to register under the Factories Act if they employ ten or more workers if the firm uses electricity or twenty and more workers if the firm does not use electricity. Registration under the Factories Act implies that the firm will need to comply with a wide range of government regulations that are exclusively applicable to the formal sector.

1.4 The rest of the paper is in four sections. In Section II, we describe our econometric methodology. In Section III, we discuss the empirical specification. Section IV describes the data and presents the results of the empirical analysis. Section V concludes.

## 2. Econometric Methodology

2.1 We use stochastic frontier analysis (SFA) to analyse firm efficiency.[4] We are interested in determining the technical efficiency of the firm – the maximum possible output that a firm can produce, given its inputs. The standard approach to SFA is the one proposed by Aigner *et al*. (1977). Under this approach, a single-equation cross-sectional stochastic production frontier model is estimated, with the assumption that firm i uses the input vector $x_i$ to produce a single output $y_i$ based on the following equation:

$$y_i = x_i b + (v_i - u_i)$$

$$\textbf{where } u_i = |\sigma_u U_i| = \sigma_u |U_i|. U_i \sim N[0,1] \quad \text{——————————} (1)$$

$$y_i = \sigma_v, v_i \sim N(0,1)$$

The model is estimated using the maximum likelihood method. However, the model does not account for selection bias.

2.2 Correcting for Selection Bias

2.2.1 The method proposed by Heckman (1976) is the conventional one used in the literature to correct for the selectivity bias. It involves two steps. In the first stage, the probit model is fit to the data and estimate the sample selection equation. In the second stage, the model (either Ordinary Least Squares or Weighted Least Squares) is fit to the selected sample data by adding the inverse Mills ratio obtained from the first step as an independent variable to correct for selectivity bias and test its significance.

2.2.2 As is argued by Greene (2006), this approach is not appropriate for models that are non-linear in nature such as probit, tobit.[5] As an alternative, Greene (2006) proposed an internally consistent method of incorporating 'sample selection' into a stochastic frontier framework. He proposes the following analytical approach:

$$d^* = \alpha' z + w, d = 1, d^* > 0 \quad \text{——————————} (2)$$

$$y = \beta' x + v - u \quad \text{——————————} (3)$$

$$u = |U|, with\ U \sim N[0, \sigma_u^2]$$

[4] For an early application of SFA to the estimation of firm efficiency in developing countries, see Taymaz and Saatci (1997).

[5] The reasons as stated by Greene (2006) include: a) the impact of the conditional mean of the estimated model may not always take the form of an inverse Mills ratio; b) though the inclusion of the inverse Mills ratio in the second step is justified based on the bivariate normality assumption, it does not generally appear in the model; and c) the dependent variable, conditioned on the sample selection, is unlikely to have the distribution described by the model in the absence of selection. Refer Greene (2006, 2010) for details.

$$(v.w) \sim bivariate\ normal\ with\ [(0,0),(\sigma_u^2,\rho\sigma_v,1)]$$
$$(y,x) only\ observed\ when\ d=1$$

where d is a probit selection equation (with adoption depending on a host of price and non-price factors) and y is the stochastic frontier function, specified only for the adopting firms.

The estimator is developed as follows:

w is conditional on v as: $\frac{w}{v} = \rho v + h\ where\ h \sim N[(0,(1,p^2)]$ and h is independent of v.

Therefore,

$$d^*|v = \alpha' z + \rho v + h, d = 1, \qquad d^* > 0|v$$

Then,

$$prob\ [d = 1\ or\ 0|z,v] = \varphi\left[(2d-1)\left(\frac{\alpha' z+\rho v}{\sqrt{1-\rho^2}}\right)\right] \text{ ——————— (4)}$$

The estimation is divided into two parts. For the selected observations, d=1, conditioned on v, the joint density for y and d is the products of the marginals as conditioned on v, y and d are independent

$$f(y,d=1|x,z,v) = f(y|x,v)prob\ (d=1|z,v)$$

This is the second part. For the first part,

$$y|x,v = (\beta' x + \sigma_v v) - \sigma_u u$$

where u is the truncation at zero of a standard normal variable. The conditional density is given by:

$$f(y|x,v) = \frac{2}{\sigma_u}\emptyset\left(\frac{(\beta' x+\sigma_v v)-y}{\sigma_u}\right), (\beta' x+\sigma_v v) - y \geq 0 \text{ ——————— (5)}$$

Therefore, the joint conditional density is given by:

$$f(y,d=1|x,z,v) = \frac{2}{\sigma_u}\emptyset\left(\frac{(\beta' x+\sigma_v v)-y}{\sigma_u}\right)\varphi\left(\frac{\alpha' z+\rho v}{\sqrt{1-\rho^2}}\right) \text{ ——————— (6)}$$

We obtain the unconditional density by integrating v out of equation (6). The integral does not exist in a closed form and hence, Greene (2006) proposes computation by simulation. The final simulated log likelihood is given by (for details see Greene 2006):

$$\log L_s = \sum_i \log \frac{1}{R}\sum_{r=1}^{R}\left\{d_i\left[\frac{2}{\sigma_u}\emptyset\left(\frac{\beta' x+\sigma_v v_{ir}-y}{\sigma_u}\right)\varphi\left(\frac{\alpha' z+\rho v_{ir}}{\sqrt{1-\rho^2}}\right)\right] + (1-d_i)\left[\varphi\left(\frac{-\alpha' z+\rho v_{ir}}{\sqrt{1-\rho^2}}\right)\right]\right\} \quad (7)$$

The model is estimated using NLOGIT version 4.

## 3. Empirical Specification

3.1 As is clear from the discussion above, the implementation of SFA with correction for selection bias involves two stages – in the first stage, estimation of a probit equation which models the selection of firms into the informal and formal sectors, and in the second stage, estimates for the production function and for technical efficiency are obtained, conditioned on the sample selection. Once we obtain the efficiency estimates, we estimate regressions where the firm level measure of efficiency is the dependent variable and the key explanatory variable is the firm's location in the formal or informal sector, along with other controls.

### 3.2 *First Stage Analysis*

3.2.1 We assume that firms can choose between being in the formal or informal sector subject to a set of variables that capture the benefits and costs of formalization. To obtain the set of explanatory variables which determine the benefits and costs of formalization, we draw from recent theoretical literature on why firms formalize. We also exploit the fact that there are important differences in institutions relating to labour regulation, access to credit and the provision of infrastructure across Indian states and over time. A key factor that has been highlighted by both the theoretical and empirical literature is the degree of regulation faced by the firm if it chooses to be in the formal sector (Fajnzylber *et al*. 2011, Ulyssea 2010, Taymaz 2009). While the regulatory framework relating to product market entry and exit are the same across states in India, labour regulations have differed greatly across Indian states. Industrial relations in India fall under the joint jurisdiction of the central and state governments. A particular piece of labour legislation that has particularly detrimental to the growth of the formal manufacturing sector in India, and has encouraged informality, is the Industrial Disputes Act (IDA) of 1947, which sets out the conciliation, arbitration and adjudication procedures to be followed in the case of an industrial dispute. The IDA applies only to formal sector firms and imposes significant restrictions on employers regarding layoff, retrenchment and closure (Ahsan *et al*. 2008). Since labour laws are both within the jurisdiction of state and central governments, the IDA has been extensively amended by state governments during the post-independence period. Besley and Burgess (2004) have coded each state amendment to labour laws as neutral, pro-worker or pro-employer for the period 1947-1997. We extended the Besley-Burgess variable till 2005 and then normalized it between 0 and 1 such that the more pro-worker labour law amendments in a state would result in lower value for that state. We would expect that more pro-employer labour law amendments *(Labour Laws*) as seen by a higher value of our variable would have a positive effect on the firm's decision to formalize.

3.2.2 A second factor highlighted by the theoretical literature is access to formal sector credit (Straub 2005). The higher the likelihood for a firm to obtain formal sector credit, which are usually on more favourable terms than informal sector credit and at lower interest rates, the more likely that the firm will choose to be in the formal sector. This is because registration as a formal sector unit is often a precondition for firms to access credit from specialized formal sources such as commercial banks and development finance institutions. In India, government regulations made it mandatory for commercial banks to lend a large

proportion of their funds to small and medium enterprises in the formal manufacturing sector (which are mostly the units that are making the transition from the informal sector) along with farmer-households in the agricultural sector – these regulations were called priority sector lending requirements (Sen and Vaidya 1997). Access to priority sector lending depended a great deal on the level of financial development in a given state, and this differed from state to state and across time (Burgess and Pande 2005). We capture differential access to formal sector credit for small and medium enterprises across Indian states and over time by the share of bank lending going to priority sectors (*Priority Sector Lending*) for 1989-90, 1994-1995, 2000-01 and 2005-06.

3.2.3 Our third variable to explain the decision of a firm to formalize is the provision of a productive public good to formal sector firms which creates a strong incentive to formalize (Dessy and Pallage 2003). We take the public good to be electricity, which has been found to be a binding constraint for formal manufacturing growth in India (World Bank 2004). Indian states have differed widely in their ability to provide electricity to manufacturing firms, in part due to the very different performance of State Electricity Boards, the main agency responsible for transmission and distribution, across Indian states (Krueger and Chinoy 2002, Panagariya 2008). We measure the electricity constraint on a firm's decision to formalise by the real price of power supply (*Cost of Power Supply*), which is less subject to endogeneity concerns in comparison to measures of electricity infrastructure such as the degree of electrification (Cali and Sen 2011). A higher price of electricity would reflect better quality of electricity provision (for example, less frequent power outages) and provide an incentive for firms to move from the informal to the formal sector to take advantage of electricity provision by the state or the private sector to registered firms, but it could also deter informal firms to move into the formal sector as the cost of production in the formal sector increases. Which of the two impacts dominates is an empirical issue.

3.2.4 Finally, we assume that the larger the firm (in terms of employment) (*Firm Size*), the more likely it will be that the firm is in the formal sector as it will be difficult for the firm not to be noticed by regulators (and state agents such as tax and labour officials) if it remains in the informal sector (Taymaz 2009).

We estimate probit model of the following type:

$$F = f(LABOUR\ LAWS,\ PRIORITY\ SECTOR\ LENDING,\ COST\ OF\ POWER\ SUPPY,\ FIRM\ SIZE) \qquad \text{———————-(8)}$$

where F is 1 if the firm is in the formal sector, 0 otherwise. We expect that the signs of the *Labour Laws*, *Priority Sector Lending* and *Firm Size* will be positive. The sign on *Cost of Power Supply* will be indeterminate.

We estimate the probit equation for each industry separately, but for all four years combined. We explain below why we estimate the probit model separately for each industry.

## 3.3 Second Stage Analysis

3.3.1 The production behaviour of formal and informal sector firms is modeled using a simple Cobb Douglas function. Thus, we have:

$$\ln(Y_{iT}) = b_0 + b_1\ln(K_{iT}) + b_2\ln(L_{iT}) + (v_{iT} - u_{iT}) \quad \text{——————————(9)}$$

Where T=1989-90. 1994-95, 2000-01 and 2005-06 and i is the firm. Y is gross value added, K is capital stock, L is labour, and bs are the parameters to be estimated. The $v_{iT}$s are random variables independent of the $u_{iT}$s and purport to capture the random shocks that are beyond the control of firms. The $u_{iT}$s capture technical inefficiency and are the combined outcome of non-price and organizational factors that constrains a firm from achieving their maximum possible output from the given set of inputs and technology. The $u_i$s are non-negative and assumed to be identically distributed at truncations at zero, $u = |U|$ with $U \sim N [0, ó^2_u]$.[6] Thus technical efficiency ($TE_i$) is measured as the ratio of the observed output of the firm to the potential output derived by the frontier function. We examine both the absolute and the relative technical efficiency of firms in our sample, where the latter is defined as the difference between the maximum absolute efficiency obtained in a given industry for a given year, and the actual absolute technical efficiency relative to the maximum absolute efficiency in that industry and year.

3.3.2 Instead of estimating the same production function for the entire set of firms, irrespective of industry, we estimate equation (9) industry by industry and for each of the two groups – formal and informal separately, at the National Industrial Classification (NIC) 2 digit industry level (broadly corresponding to the ISIC 3 digit level of industrial classification used by the United Nations Industrial Development Organization). There are twenty-two industries in our data-set (we provide the list of industries along with the industry codes in Appendix A). By estimating the production function separately for formal and informal firms at the industry level, we not only allow the parameters for capital and labour in the firm-level production function to differ across industries but also across the two groups. This is a reasonable assumption to make when a) the industries differ so widely in their production technology and in characteristics relating to export orientation and market structure (e.g., leather versus electrical machinery); and b) even within the same industry, production coefficients may be different for labour-intensive informal firms and capital-intensive formal firms.

3.3.3 Once we have estimated efficiency at the firm level, we regress firm-specific technical efficiency on whether the firm is in the formal or informal sector as follows:

$$TE_{ijt} = á + â*FORMAL_{ijt} + ä_j + ã_t + å\text{-}_{ijt} \quad \text{——————————(10)}$$

Where $TE_{ijt}$ is technical efficiency of firm i in industry j and year t, *FORMAL* is a dummy which takes the value one if the firm is in the formal sector, and zero if the firm is in the

[6] The inefficiency term can be modeled using truncated normal, half-normal or exponential distributions. We assume that the inefficiency term follows the truncated normal distribution though we have also estimated efficiency using the half-normal distribution without any change in our results.

informal sector, ä$_j$ are industry fixed effects, ã$_t$ are year effects and å-$_{ijt}$ is the error term. If â is greater than zero (and statistically significant), formal firms are more efficient than informal firms and vice versa. We estimate the above equation using Ordinary Least Squares – we do not need to use instrumental variable methods as our first stage analysis precludes the possibility that firms with higher technical efficiency tend to move to the formal sector, and therefore, of simultaneity bias. We use our estimates of absolute and relative technical efficiency alternately as our dependent variable in the estimation of equation (10).

## 4. Results

4.1 We use unit level data for the formal and informal manufacturing sectors for four years, 1989-90, 1994-95, 2000-01 and 2005-06.[7] The choice of years is governed by the fact that the data on informal sector firms are only available for these years. Data on the formal manufacturing sector is drawn from the Annual Survey of Industries (ASI), undertaken by the Central Statistical Organization (CSO), which is the annual census-cum-sample survey of all the formal manufacturing units for all the industries across all the states. For the informal sector, we use the National Sample Survey Organization (NSSO) surveys on the informal manufacturing sector, which are undertaken quinquennially using a stratified sampling procedure.[8] It is to be noted that during the sixteen years of our analysis period, industrial classification has undergone some changes. For instance, ASI data for 2005-06 uses NIC 1998 codes, whereas 1994-95 and 2000-01 data uses NIC 1987 codes. Similarly, NSSO data for 1989-90 and 1994-95 are based on NIC 1987, whereas 2000-01 data is based on NIC 1998 and 2005-06 data is based on NIC 2004. We harmonized the whole data at NIC 1998 codes. The average number of firms in the formal sector that we use in our empirical analysis is 25,000 and for the informal sector, 28,000.

Labour regulation data till 1997 comes from Besley and Burgess (2004), and we have updated it using similar coding procedures till 2005. Data on priority credit share for the selected states are drawn from Burgess and Pande (2005) till 1995, and we have updated it for the years 2000-01 and 2005-06 from an annual publication titled Statistical Tables Relating to Banks in India published by the Reserve Bank of India (RBI). The data on the cost of power supply comes from the Indian Planning Commission (2002).

We first present the results for the first stage estimation followed by the results for the second stage estimation.

### 4.2 First Stage Estimation

4.2.1 Table 1 presents the descriptive statistics for the main variables that we use in our first stage probit model estimation. On average, priority sectors such as small-scale industries, services and agriculture together received about 31 per cent of the total bank

[7] Data are in the form of repeated cross-sections, and not in panel form. This is because the Indian statistical agencies do not reveal the identity of the firm/plant in the unit level data, and for the informal sector, the same firms may not be surveyed in each round.

[8] We limit our analysis of informal firms to only those which hire outside labour, as there are serious limitations on the quality of data for household enterprises.

lending for the period 1989-90 to 2005-06. It is clearly evident from the Table that average value added per employee is considerably higher for firms in the formal sector as compared to their counterparts in the informal sector. Evidence also points to significant differences in the level of input use between firms in the formal and informal sector. The capital-labour ratio computed for both the sectors suggest the highly capital intensive nature of production process employed in the formal sector vis-à-vis the informal sector. The labour regulation variable suggests that, on average, labour laws in India have been pro-worker.

4.2.2 We present the results of the first stage probit equation estimation in Table 2. The chi-square test statistic in the probit selection equation is significant at the 1 per cent level in all the industries except three industries, namely medical, precision and optical instruments, office machinery and basic metal industries. As expected, the likelihood of the firm being in the formal sector is positively correlated with firm size. We also find that weaker labour regulation significantly and positively influences the firm's decision to be in the formal sector. By and large, wherever the variable is significant in the industry by industry results, there seems to be a positive relationship between the availability of power supply and the firm's decision to be in the formal sector. This suggest that the greater the quality of the electricity supplied in a given state, the more likely is it that firms in that state will be formalized. In most industries, greater availability of priority sector lending from commercial banks seems to have a greater likelihood of firms to be in the formal sector.

## 4.3 Second Stage Estimation

4.3.1 Table 3 gives the summary statistics for variables used in estimating stochastic production frontier for formal and informal firms separately. As is evident from the table, the informal firms on an average use less labour and capital and produces less, though the variation is smaller for the group. Is the use of labour and capital relatively more inefficient for informal firms? This is investigated next.

4.3.2 The maximum likelihood estimates of the parameters of the model obtained from estimating the stochastic production frontier model separately for 22 industries are presented for 1989-90, 1994-95, 2000-01 and 2005-06 in Tables 4 and 5 respectively.[9] The models estimated by the maximum likelihood method are highly significant as shown by the large likelihood values. The coefficient of the selectivity variable ($\tilde{n}_{w,v}$) is significantly different from zero at the 5% level in most of the industries especially for 2000-01 and 2005-06, which confirms that serious selection bias exists, thereby supporting the use of a sample-selection framework in the stochastic frontier model. The results of the stochastic

[9] The variables for the stochastic frontier model are real value added and real capital stock at 1993-94 prices and employment. We omitted observations for which real value added, real capital and the labour variables are less than or equal to zero. Real value added is obtained by deflating nominal value added using the wholesale price index (WPI) for manufactured products at the four digit industry level. Labour is measured as total number of persons engaged in the production activity, which include production workers as well as employees. Real capital stock is constructed by deflating gross fixed assets by WPI for machine and machinery tools. To ensure that the empirical analysis is not sensitive to the inclusion of outliers, we have dropped all firms where real capital stock, employment or real output are more than two standard deviations from the industry means of these variables.

production frontier models show that as expected in a labour surplus economy, labour is a more important input than capital in the production function. The coefficient of labour is higher than that of capital for most industries and for most years irrespective of the group suggesting that labour is a more important input than capital in the production function, which is a quite plausible finding for a labour surplus economy like India. For informal sector, we find elasticity of labour or capital is negative in some industries. This could be because of two reasons – first, some of these industries are highly capital intensive, thereby having less scope for informal firms (for example, Petroleum); and second, the estimates for these industries are not consistent due to less degrees of freedom as these industries consist of only few informal firms (for example, Office Machinery). We also examine whether there has been any changes in the estimated parameters of the industry production functions over time. Our results preclude any such possibility in the formal sector as the t-ratio for differences in coefficients is found to be insignificant for most industries and most years. However, the t-test for differences in coefficients do suggest changes in estimated parameters over time for the informal sector with the sector reporting increasing returns to scale for the later period.

4.3.3 Figure 1 gives the estimated technical efficiency and relative technical efficiency of formal and informal groups. We observe that formal firms, on average, are more efficient and closer to the frontier than informal firms. We next examine whether this observation is supported by regression analysis. We first pool our efficiency estimates for both formal and informal firms in one data-set. We then use Ordinary Least Squares in this combined data-set, regressing the efficiency estimates on the formal sector dummy, as in equation (10). To take into account that efficiency may be impacted by macro shocks and that efficiency may be correlated with unobserved industry characteristics, we see how robust our results are to the inclusion of year and industry effects. We present our results in Table 6. We present estimates for both absolute and relative technical efficiency. Cols (1) to (2) present the results for absolute technical efficiency while Cols (3) to (4) present the results for relative technical efficiency. In Col. (1) and (3), we present the results without industry effects but with year effects, and in Cols (2) and (4), with both industry and year effects. Our regression results clearly show that formal firms are more efficient than informal firms, – as the coefficient on the formal sector dummy is statistically significant at the 1 per cent level. This is independent of year- and sector-effects. However, the informal firms are closer to the frontier.

## 4.4 Does Location Matter for Efficiency?

4.4.1 In order to see, whether this higher efficiency of formal firms holds true irrespective of their location (LOCATION) – we use an interaction term with FORMAL in the following manner.

$$TE_{ijt} = \acute{a} + \hat{a}_1 * FORMAL_{ijt} \times Z_{ijt} + \ddot{a}_j + \tilde{a}_t + \mathring{a}\text{-}_{ijt} \qquad \text{——————————(10)}$$

Where $TE_{ijt}$ is technical efficiency of firm i in industry j and year t, , Z is the location variable, $\ddot{a}_j$ are industry fixed effects, $\tilde{a}_t$ are year effects and $\mathring{a}\text{-}_{ijt}$ is the error term. If $\hat{a}_1$ is greater than zero (and statistically significant), formal firms are more efficient than informal firms for that characteristic.

4.4.2 For location, we have information about whether firm is located in Rural or Urban area. We expect that firms in urban areas to be more efficient due to greater access of public goods and also having more access to information, labour market pooling and market for other components and allied services. However it is not clear which category of firms - formal or informal would make use of their location better. This would be interesting to see.

4.4.3 We measure location as a dummy having two values – RURAL and URBAN having value of one if the firm is located in rural area and urban areas respectively.

$$TE_{ijt} = \acute{a} + \hat{a}_1 * FORMAL \text{ x } \text{RURAL}_{ijt} + \hat{a}_2 * FORMAL \text{ x } \text{URBAN}_{ijt} + \ddot{a}_j + \tilde{a}_t + \mathring{a}\text{-}_{ijt} \quad \text{— (11)}$$

We expect $b_1$ to be positive if formal firms are more efficient. However, if formal firms make use of their location better, $b_2$ will not only be positive but also greater than $b_1$. The results are given in Table 7. Before we discuss results, we give kernel density plot (Figure 2) that compares efficiency of formal and informal firms with respect to their location.

4.4.4 From the figure we can make following inferences – a) formal more efficient than informal – irrespective of whether in Rural or urban areas; b) Formal firms on an average becoming more efficient in both rural and urban areas (Figure 2).

4.4.5 To see whether these differences are statistically significant or not we estimate equations 11 for which results are given in Table 7. From the table, we can make following inferences: formal firms more efficient whether located in Rural or Urban area; whereas, informal firms are more closer to their frontier. Based on the results, we can say that formal firms are more efficient irrespective of their location.

## 5. Conclusion

5.1 Whether formal firms are more efficient than informal firms is a matter of empirical inquiry. In this paper, we use unit record data for the informal and formal manufacturing sectors combined from four repeated cross-sections over the period 1989-2005 and use stochastic frontier analysis applied to twenty-two industries to calculate absolute and relative efficiency at the firm-level for the Indian economy to examine whether formal firms are more efficient than formal firms. We use a recent econometric methodology proposed by Greene (2010) to correct for selection bias in the firm's decision to be in the informal or formal sectors in the estimates of efficiency using stochastic frontier analysis. To do this, we estimate probit equations in the first stage to capture the likelihood of the firm being in the formal or informal sector. Our first stage results indicate that except three industries, namely medical, precision and optical instruments, office machinery and basic metal industries, there exists selection bias. The likelihood of the firm being in the formal sector is positively linked to its size, less stringent labour regulation, the availability of power supply and priority sector lending to small-scale firms from commercial banks.

5.2 We then use stochastic frontier analysis to estimate firm-level estimates of efficiency in the second stage of our empirical analysis, correcting for selection bias. We use the

firm-specific estimates of absolute and relative technical efficiency and pooled Ordinary Least Squares methods to examine whether formal firms are more efficient than informal firms. We find that formal firms are more efficient than informal firms, both for absolute and relative efficiency – the coefficient on the formal sector dummy is statistically significant at the 1 per cent level, controlling for year and industry effects.

5.3 In next stage we find that the results hold irrespective of their location - rural or urban. We find that formal firms in urban areas are more efficient. This suggests that there are clear benefits of easing the transition of informal firms to the formal sector. The paper thus provides empirical support for the proposition that policy-makers should relax regulations that may allow more informal sector firms to relocate to the formal sector.

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**Table 1: Descriptive statistics at the aggregate level: 1989-2006 (N = 219,393 – ASI = 110,014, NSSO = 109,369)**

| | Mean | Standard deviation |
|---|---|---|
| Labour regulation index (pro-worker: +1; pro-employer: -1) | 0.576 | 0.235 |
| Cost of power supply, state level, (Rs./Kwhr) | 5.323 | 0.5422 |
| Share of priority sector lending, state-level (percent) | 31.457 | 9.883 |
| Firm size (log (ln) employment) | 2.652 | 1.557 |
| Ln formal manufacturing value added per employee | 10.719 | 1.126 |
| Ln informal manufacturing value added per employee | 8.920 | 1.199 |
| Ln formal manufacturing capital labour ratio | 10.454 | 1.727 |
| Ln informal manufacturing capital labour ratio | 9.821 | 1.341 |
| Ln formal manufacturing employment (No.) | 3.893 | 1.211 |
| Ln informal manufacturing employment (No.) | 1.404 | 0.529 |

*Notes*: The data are for the 15 major sates for the period 1989-2006. Since Bihar, MP and UP were bifurcated in 2000 to form the new states, Uttarakhand, Chhattisgarh and Jharkhand, we have merged these three states with their parent states so as to have consistent data for the study period.

**Table 2: Parameter Estimates of the Probit Selection Equation, Industry Level, All Years**

| Industries | Cons-tant | Size | Labour regu-lation | Power | Priority -sector lending | Log likeli hood | Ma Fadden R-square | N | Chi squared |
|---|---|---|---|---|---|---|---|---|---|
| Food | -7.54* | 2.45* | 0.89* | 0.33* | -0.01* | -5072.35 | 0.81 | 38978 | 154.53 |
| | (0.21) | (0.03) | (0.07) | (0.03) | (0.002) | | | | |
| Tobacco | -9.32* | 1.31* | -1.43* | 0.92* | 0.07* | -1064.94 | 0.65 | 4449 | 28.70 |
| | (0.48) | (0.04) | (0.14) | (0.07) | (0.01) | | | | |
| Textiles | -10.22* | 2.84* | 0.38* | 0.43* | 0.01* | -3955.03 | 0.83 | 35138 | 203.86 |
| | (0.26) | (0.04) | (0.07) | (0.04) | (0.001) | | | | |
| Apparel | -23.90* | 11.60* | 0.14 | -0.41 | 0.001 | -98.57 | 0.98 | 12320 | |
| | (2.96) | (1.21) | (0.48) | (0.26) | (0.01) | | | | |
| Leather | -7.79* | 2.90* | 1.26* | 0.07 | 0.01* | -490.19 | 0.82 | 4035 | 16.90 |
| | (0.68) | (0.12) | (0.18) | (0.11) | (0.005) | | | | |
| Wood | -6.10* | 2.48* | 0.18* | 0.10* | 0.01* | -1930.47 | 0.66 | 9400 | 149.49 |
| | (0.32) | (0.06) | (0.11) | (0.05) | (0.003) | | | | |
| Paper | -5.92* | 2.42* | 0.65* | 0.09 | 0.0003 | -661.49 | 0.67 | 3692 | 10.53 |
| | (0.60) | (0.09) | (0.19) | (0.09) | (0.004) | | | | |
| Publishing | -7.76* | 2.88* | 0.27* | 0.17* | 0.01* | -973.04 | 0.80 | 7122 | 30.49 |
| | (0.47) | (0.08) | (0.14) | (0.07) | (0.004) | | | | |
| Petroleum | -4.94* | 1.52* | 1.79* | 0.23 | 0.01 | -208.23 | 0.57 | 1259 | 17.50 |
| | (0.89) | (0.11) | (0.36) | (0.14) | (0.01) | | | | |
| Chemicals | -5.44* | 1.93* | -0.74* | 0.24* | 0.01* | -2044.35 | 0.62 | 11649 | 12.55 |
| | (0.33) | (0.05) | (0.11) | (0.05) | (0.002) | | | | |
| Rubber | -7.83* | 2.31* | 0.59* | 0.40* | 0.01* | -1459.21 | 0.67 | 6848 | 24.91 |
| | (0.41) | (0.06) | (0.13) | (0.06) | (0.003) | | | | |
| Minerals | -4.12* | 1.51* | 0.77* | -0.02 | 0.01* | -5131.86 | 0.54 | 16634 | 44.73 |
| | (0.21) | (0.02) | (0.07) | (0.03) | (0.002) | | | | |
| Basic metal | -5.73* | 2.30* | 0.83* | 0.21* | -0.01* | -970.82 | 0.69 | 7594 | 3.46 |
| | (0.47) | (0.07) | (0.15) | (0.07) | (0.003) | | | | |
| Metal products | -8.32* | 2.83* | 0.32* | 0.33* | 0.01* | -2585.47 | 0.78 | 17146 | 153.99 |
| | (0.30) | (0.05) | (0.09) | (0.04) | (0.002) | | | | |
| Machinery | -7.40* | 2.42* | 1.05* | 0.36* | -0.004* | -2386.36 | 0.73 | 13571 | 88.99 |
| | (0.30) | (0.05) | (0.10) | (0.05) | (0.002) | | | | |
| Office machinery | -2.55* | 2.08* | -0.46 | -0.57 | 0.04* | -34.98 | 0.69 | 294 | 1.38 |
| | (2.18) | (0.38) | (0.76) | (0.38) | (0.02) | | | | |
| Electrical machinery | -5.91* | 2.39* | 0.52* | 0.005 | 0.02* | -874.18 | 0.73 | 5281 | 24.94 |
| | | (0.50) | (0.08) | (0.17) | (0.08) | (0.004) | | | |
| Radio & Television | -7.00* | 2.40* | 1.50* | 0.05 | 0.03* | -134.77 | 0.74 | 1353 | 3.75 |
| | (1.23) | (0.19) | (0.43) | (0.19) | (0.009) | | | | |
| Medical, precision & optical instrmnts | -5.71* | 2.40* | 1.60* | 0.05 | -0.009 | -196.34 | 0.74 | 1427 | 0.62 |
| | (0.99) | (0.16) | (0.35) | (0.15) | (0.007) | | | | |
| Motor vehicles | -4.14* | 2.14* | 0.03 | -0.09 | 0.001 | -527.59 | 0.67 | 3162 | 8.71 |
| | (0.72) | (0.10) | (0.23) | (0.11) | (0.005) | | | | |
| Transport equipment | -4.58* | 2.02* | 1.24* | 0.11 | -0.02* | -647.97 | 0.65 | 3241 | 34.60 |
| | (0.56) | (0.08) | (0.23) | (0.09) | (0.004) | | | | |
| Furniture and nec. | -5.90* | 2.28* | 0.77* | -0.04 | 0.01* | -1850.72 | 0.71 | 14843 | 96.01 |
| | (0.33) | (0.05) | (0.12) | (0.05) | (0.003) | | | | |

*Notes*: a) N is the total number of firms; b) * and ** indicates level of significance at 5 per cent and 10 per cent respectively; c) Figures in parenthesis are standard errors.

**Table 3: Summary Statistics for Second Stage Estimation – average over 1989-90 to 2005-06**

| Industry | Informal Sector | | | Formal Sector | | |
|---|---|---|---|---|---|---|
| | Y | K | L | Y | K | L |
| Food | 9.96 (6.93-13.04) | 10.99 (7.36-14.50) | 1.24 (0.69-2.48) | 14.52 (10.68-18.54) | 14.32 (9.39-19.30) | 4.01 (1.39-6.73) |
| Tobacco | 9.63 (6.99-12.26) | 10.18 (7.07-13.12) | 1.39 (0-3.18) | 13.85 (9.37-18.44) | 11.77 (3.58-18.92) | 4.21 (0.69-7.95) |
| Textiles | 10.37 (7.44-13.20) | 10.93 (7.40-14.32) | 1.57 (0.69-2.71) | 15.10 (11.12-19.15) | 15.12 (9.96-20.21) | 4.34 (1.61-7.36) |
| Apparel | 9.84 (6.72-13.11) | 11.14 (8.80-13.53) | 1.14 (0.69-2.20) | 15.38 (12.19-18.40) | 14.90 (10.67-18.89) | 4.69 (2.08-7.21) |
| Leather | 10.51 (7.43-13.57) | 11.02 (7.81-14.15) | 1.40 (0.69-2.56) | 14.74 (11.32-18.08) | 14.64 (10.49-18.69) | 4.01 (1.39-6.73) |
| Wood | 10.19 (7.26-12.96) | 10.90 (6.96-14.59) | 1.27 (0.69-2.30) | 12.98 (10.13-16.04) | 12.63 (8.27-16.87) | 2.88 (1.10-5.07) |
| Paper | 11.07 (7.89-14.17) | 12.12 (8.82-15.14) | 1.63 (0.69-2.83) | 14.55 (11.00-18.35) | 14.60 (10.19-19.36) | 3.63 (1.39-6.34) |
| Publishing | 10.28 (7.10-13.29) | 11.92 (8.43-15.05) | 1.34 (0.69-2.40) | 14.23 (10.63-17.93) | 14.01 (9.01-18.93) | 3.62 (1.39-6.14) |
| Petroleum | 10.43 (7.21-13.51) | 11.71 (8.12-15.04) | 1.63 (0.69-2.71) | 14.72 (10.41-19.71) | 14.99 (9.97-20.38) | 3.73 (1.10-6.66) |
| Chemicals | 11.04 (7.51-14.54) | 12.06 (8.43-15.50) | 1.82 (0.69-3.14) | 15.15 (11.00-19.57) | 14.91 (9.58-20.44) | 4.14 (1.61-6.98) |
| Rubber | 11.25 (7.82-14.54) | 12.47 (8.76-15.82) | 1.64 (0.69-2.77) | 14.64 (11.26-18.27) | 14.64 (10.64-18.92) | 3.55 (1.39-6.13) |
| Minerals | 10.59 (7.45-13.73) | 11.42 (7.60-15.08) | 1.83 (0.69-3.56) | 13.75 (10.20-17.87) | 13.36 (8.84-18.57) | 3.65 (1.39-6.25) |
| Basic metal | 10.76 (7.31-14.27) | 11.86 (8.23-15.43) | 1.55 (0.69-2.77) | 14.97 (11.10-19.18) | 14.98 (10.15-20.13) | 3.97 (1.39-6.86) |
| Metal products | 10.54 (7.44-13.55) | 11.52 (8.13-14.66) | 1.35 (0.69-2.40) | 14.23 (10.87-17.89) | 13.83 (9.67-18.19) | 3.50 (1.39-6.11) |
| Machinery | 10.79 (7.56-13.93) | 11.91 (8.23-15.29) | 1.41 (0.69-2.56) | 14.54 (10.98-18.44) | 14.20 (9.94-18.74) | 3.60 (1.10-6.38) |
| Office machinery | 12.43 (9.73-14.57) | 12.96 (10.97-15.88) | 1.85 (0.69-3.00) | 16.11 (11.84-20.35) | 15.66 (11.20-19.47) | 4.27 (1.79-6.69) |
| Electrical machinery | 10.77 (7.17-14.52) | 11.98 (8.32-15.20) | 1.46 (0.69-2.77) | 15.02 (11.24-19.20) | 14.51 (9.99-19.34) | 3.75 (1.39-6.59) |
| Radio & Television | 11.70 (7.74-15.42) | 12.33 (8.79-15.32) | 1.70 (0.69-3.00) | 15.70 (11.60-20.08) | 15.37 (10.49-20.32) | 4.19 (1.61-7.02) |
| Medical, precision inst. | 11.17 (7.85-14.48) | 11.87 (8.61-14.90) | 1.49 (0.69-2.77) | 15.08 (11.40-18.76) | 14.63 (10.11-19.11) | 3.79 (1.39-6.44) |
| Motor vehicles | 11.38 (8.33-14.29) | 12.53 (9.81-15.10) | 1.72 (0.69-2.89) | 15.33 (11.27-19.59) | 15.30 (10.49-20.34) | 4.18 (1.39-7.26) |
| Transport equipment | 11.05 (7.94-14.10) | 12.18 (1.38-8.28) | 1.58 (0.69-2.71) | 14.82 (10.95-19.08) | 14.37 (9.72-19.40) | 3.84 (1.10-7.13) |
| Furniture | 10.24 (7.18-13.30) | 10.96 (7.68-14.03) | 1.28 (0.69-2.56) | 14.07 (10.32-18.14) | 13.38 (8.17-18.59) | 3.39 (1.10-6.10) |

*Note*: Figures in the parentheses show the ranges for the respective variables; Y, K and L represent log of real gross value added, real fixed capital stock and number of workers respectively.

**Table 4a: Estimated production parameters, industry level, 1989-90 and 1994-95 (Formal Firms)**

| Industry | 1989-90 | | | | | | 1994-95 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Constant | Ln K | Ln L | Log L | Rho | N | Constant | Ln K | Ln L | Log L | Rho | N |
| Food | 7.57* (0.15) | 0.35* (0.01) | 0.61* (0.02) | -4356.28 | -0.08 (0.09) | 3597 | 6.73* (0.12) | 0.38* (0.01) | 0.67* (0.01) | -9955.52 | 0.04 (0.04) | 6766 |
| Tobacco | 8.59* (0.65) | 0.19* (0.02) | 0.72* (0.06) | -771.78 | -0.10 (0.19) | 477 | 8.26* (0.33) | 0.24* (0.01) | 0.76* (0.04) | -1340.60 | 0.02 (0.11) | 840 |
| Textiles | 6.96* (0.17) | 0.32* (0.01) | 0.82* (0.02) | -2932.03 | 0.20* (0.08) | 2103 | 7.26* (0.10) | 0.34* (0.01) | 0.66* (0.02) | -6103.41 | 0.13* (0.05) | 4432 |
| Apparel | 8.03* (0.79) | 0.35* (0.03) | 0.50* (0.06) | -375.97 | 0.10 (0.65) | 306 | 8.06* (0.33) | 0.37* (0.02) | 0.44* (0.03) | -1366.52 | -0.35 (0.60) | 1012 |
| Leather | 7.91* (0.59) | 0.30* (0.05) | 0.67* (0.07) | -492.13 | -0.45 (0.29) | 350 | 7.56* (0.49) | 0.27* (0.02) | 0.77* (0.04) | -977.52 | 0.01 (0.21) | 759 |
| Wood | 7.96* (0.60) | 0.23* (0.03) | 0.73* (0.08) | -740.03 | 0.26* (0.15) | 535 | 8.07* (0.22) | 0.24* (0.02) | 0.75* (0.05) | -1394.81 | 0.12 (0.12) | 1025 |
| Paper | 8.08* (0.31) | 0.33* (0.02) | 0.63* (0.06) | -612.75 | -0.12 (0.48) | 492 | 7.11* (0.21) | 0.35* (0.02) | 0.77* (0.04) | -1147.83 | 0.20 (0.25) | 926 |
| Publishing | 7.20* (0.21) | 0.30* (0.02) | 0.85* (0.04) | -961.20 | 0.09 (0.16) | 779 | 7.42* (0.20) | 0.28* (0.01) | 0.92* (0.03) | -1278.57 | 0.03 (0.14) | 1061 |
| Petroleum | 4.47* (0.82) | 0.46* (0.04) | 0.85* (0.07) | -286.72 | 0.28 (0.53) | 194 | 4.55* (0.75) | 0.55* (0.03) | 0.60* (0.05) | -524.74 | -0.82* (0.13) | 357 |
| Chemicals | 5.75* (0.21) | 0.51* (0.01) | 0.61* (0.03) | -2716.27 | -0.22 (0.20) | 1861 | 6.08* (0.14) | 0.45* (0.01) | 0.67* (0.02) | -4612.17 | 0.12 (0.13) | 3289 |
| Rubber | 7.86* (0.31) | 0.33* (0.02) | 0.71* (0.05) | -1116.25 | 0.37* (0.20) | 802 | 6.90* (0.19) | 0.35* (0.01) | 0.84* (0.05) | -1947.59 | 0.48* (0.15) | 1586 |
| Minerals | 6.43* (0.17) | 0.30* (0.01) | 0.85* (0.03) | -2471.65 | 0.61* (0.09) | 1977 | 6.46* (0.13) | 0.34* (0.01) | 0.82* (0.02) | -4351.07 | 0.31* (0.10) | 3395 |
| Basic metal | 6.51* (0.39) | 0.46* (0.03) | 0.47* (0.06) | -1831.99 | 0.44 (0.42) | 1268 | 6.65* (0.27) | 0.34* (0.01) | 0.77* (0.02) | -2753.51 | 0.14 (0.14) | 2231 |
| Metal products | 7.59* (0.19) | 0.24* (0.01) | 0.95* (0.03) | -1805.86 | 0.43* (0.13) | 1422 | 6.97* (0.24) | 0.30* (0.01) | 0.85* (0.02) | -2952.08 | 0.13 (0.09) | 2443 |
| Machinery | 7.18* (0.16) | 0.30* (0.01) | 0.94* (0.03) | -2183.91 | 0.48* (0.13) | 1771 | 7.51* (0.13) | 0.30* (0.01) | 0.85* (0.02) | -3507.10 | 0.15* (0.08) | 2878 |
| Office machinery | 6.97* (1.07) | 0.31* (0.08) | 1.10* (0.12) | -77.46 | 1.00 10.25) | 65 | 5.87* (1.35) | 0.51* (0.09) | 0.64* (0.13) | -151.07 | -0.68 (1.11) | 99 |
| Electrical machinery | 6.55* (0.52) | 0.35* (0.02) | 0.85* (0.04) | -933.50 | -0.17 (0.26) | 712 | 7.16* (0.34) | 0.31* (0.02) | 0.88* (0.03) | -1565.09 | 0.02 (0.20) | 1247 |
| Radio & Television | 7.03* (0.76) | 0.33* (0.06) | 0.77* (0.10) | -276.47 | 0.60 (0.62) | 195 | 7.43* (0.38) | 0.34* (0.03) | 0.81* (0.07) | -691.09 | -0.32 (0.40) | 502 |
| Medical, precision inst. | 8.67* (0.58) | 0.26* (0.05) | 0.81* (0.10) | -259.45 | 0.00 (0.42) | 193 | 7.80* (0.43) | 0.30* (0.03) | 0.84* (0.06) | -420.35 | 0.96* (0.24) | 328 |
| Motor vehicles | 6.18* (0.69) | 0.35* (0.03) | 0.85* (0.05) | -358.00 | -0.18 (0.54) | 329 | 6.76* (0.39) | 0.32* (0.02) | 0.87* (0.03) | -764.52 | 0.27 (0.18) | 702 |
| Transport equipment | 8.01* (0.76) | 0.22* (0.03) | 0.89* (0.05) | -547.11 | 0.22 (0.30) | 401 | 7.53* (0.23) | 0.29* (0.02) | 0.85* (0.03) | -1135.97 | 0.32* (0.14) | 894 |
| Furniture | 7.29* (0.35) | 0.28* (0.03) | 0.87* (0.07) | -681.00 | 0.07 (0.19) | 450 | 6.98* (0.47) | 0.29* (0.02) | 0.91* (0.05) | -1283.84 | 0.12 (0.10) | 771 |

*Notes:* a) Ln K and ln L are natural logarithms of capital stock and labour respectively; b) Log L is the value of the log likelihood function, Rho is selection parameter; and N is the total number of firms; d) * indicates level of significance at 5 per cent; e) Figures in parenthesis are standard errors.

**Table 4b: Estimated production parameters, industry level, 2000-01 and 2005-06 (Formal Firms)**

| Industry | 2000-01 | | | | | | 2005-06 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Constant | Ln K | Ln L | Log L | Rho | N | Constant | Ln K | Ln L | Log L | Rho | N |
| Food | 6.11* (0.11) | 0.44* (0.01) | 0.66* (0.02) | -9055.74 | 0.11* (0.06) | 4137 | 6.66* (0.11) | 0.43* (0.01) | 0.56* (0.01) | -6533.19 | -0.08 (0.06) | 5676 |
| Tobacco | 7.58* (0.68) | 0.24* (0.02) | 0.81* (0.05) | -659.94 | -0.11 (0.16) | 402 | 7.23* (0.50) | 0.27* (0.01) | 0.87* (0.04) | -1067.91 | -0.09 (0.12) | 656 |
| Textiles | 7.55* (0.13) | 0.38* (0.01) | 0.56* (0.02) | -3889.29 | -0.15* (0.06) | 2648 | 7.76* (0.10) | 0.38* (0.01) | 0.62* (0.01) | -4861.61 | -0.25* (0.05) | 3680 |
| Apparel | 8.30* (0.29) | 0.33* (0.02) | 0.61* (0.03) | -893.34 | 0.48* (0.20) | 770 | 8.85* (0.22) | 0.28* (0.01) | 0.61* (0.02) | -1098.24 | -0.39* (0.22) | 1042 |
| Leather | 8.39* (0.40) | 0.26* (0.03) | 0.78* (0.05) | -529.66 | -0.16 (0.20) | 405 | 7.27* (0.59) | 0.38* (0.02) | 0.52* (0.03) | -710.77 | -0.01 (0.12) | 559 |
| Wood | 7.23* (0.35) | 0.28* (0.02) | 0.90* (0.09) | -847.22 | 0.21 (0.15) | 469 | 7.75* (0.30) | 0.29* (0.01) | 0.79* (0.09) | -1083.45 | -0.08 (0.14) | 627 |
| Paper | 7.67* (0.29) | 0.34* (0.02) | 0.64* (0.04) | -681.14 | -0.41* (0.12) | 575 | 7.89* (0.21) | 0.36* (0.02) | 0.62* (0.04) | -1013.39 | -0.21* (0.10) | 831 |
| Publishing | 6.40* (0.54) | 0.35* (0.02) | 0.80* (0.05) | -757.13 | -0.10 (0.13) | 528 | 6.98* (0.40) | 0.34* (0.01) | 0.74* (0.04) | -963.62 | -0.11 (0.10) | 714 |
| Petroleum | 4.76* (0.96) | 0.49* (0.03) | 0.69* (0.06) | -318.56 | -0.46* (0.22) | 203 | 3.96* (0.76) | 0.47* (0.03) | 1.00* (0.05) | -425.10 | 0.52* (0.18) | 277 |
| Chemicals | 6.51* (0.19) | 0.42* (0.01) | 0.67* (0.03) | -2957.92 | 0.24* (0.12) | 1974 | 7.61* (0.16) | 0.39* (0.01) | 0.58* (0.02) | -3769.07 | -0.13 (0.09) | 2492 |
| Rubber | 7.14* (0.29) | 0.40* (0.02) | 0.60* (0.04) | -1127.65 | -0.40* (0.11) | 829 | 8.08* (0.19) | 0.35* (0.01) | 0.65* (0.03) | -1776.14 | -0.11 (0.10) | 1334 |
| Minerals | 6.24* (0.19) | 0.40* (0.01) | 0.70* (0.03) | -2822.38 | -0.10 (0.10) | 1779 | 7.07* (0.16) | 0.37* (0.01) | 0.70* (0.03) | -4946.57 | -0.30* (0.06) | 3122 |
| Basic metal | 7.54* (0.20) | 0.35* (0.02) | 0.68* (0.03) | -1503.30 | -0.47* (0.13) | 1164 | 8.19* (0.17) | 0.35* (0.01) | 0.64* (0.03) | -2387.69 | -0.62* (0.07) | 1823 |
| Metal products | 7.99* (0.18) | 0.31* (0.01) | 0.73* (0.03) | -1691.65 | -0.26* (0.08) | 1142 | 8.30* (0.15) | 0.34* (0.01) | 0.56* (0.02) | -2533.25 | -0.40* (0.05) | 1825 |
| Machinery | 7.66* (0.17) | 0.31* (0.01) | 0.82* (0.02) | -2273.62 | 0.03* (0.09) | 1687 | 7.74* (0.14) | 0.34* (0.01) | 0.74* (0.02) | -2853.54 | -0.20* (0.06) | 2299 |
| Office machinery | 5.71* (1.68) | 0.57* (0.14) | 0.55* (0.17) | -60.18 | 0.99* (0.53) | 49 | 11.08* (1.43) | 0.16* (0.14) | 0.93* (0.23) | -61.70 | -0.99 (0.002) | 43 |
| Electrical machinery | 7.92* (0.26) | 0.34* (0.02) | 0.76* (0.04) | -1073.98 | -0.22 (0.14) | 750 | 8.32* (0.25) | 0.33* (0.02) | 0.74* (0.04) | -1318.18 | -0.12 (0.13) | 944 |
| Radio & Television | 7.49* (0.53) | 0.38* (0.04) | 0.74* (0.06) | -292.97 | -0.72* (0.32) | 248 | 10.71* (0.64) | 0.21* (0.05) | 0.71* (0.09) | -333.99 | -0.45* (0.18) | 238 |
| Medical, precision inst. | 8.53* (0.46) | 0.32* (0.04) | 0.69* (0.06) | -386.39 | -0.53* (0.20) | 290 | 9.74* (0.52) | 0.28* (0.04) | 0.63* (0.08) | -428.31 | -0.61* (0.19) | 306 |
| Motor vehicles | 7.00* (0.24) | 0.37* (0.02) | 0.76* (0.04) | -744.36 | -0.18 (0.18) | 621 | 7.96* (0.27) | 0.34* (0.02) | 0.70* (0.04) | -1096.71 | -0.28* (0.16) | 882 |
| Transport equipment | 7.44* (0.38) | 0.34* (0.03) | 0.71* (0.05) | -596.37 | -0.09 (0.17) | 475 | 7.98* (0.22) | 0.36* (0.02) | 0.62* (0.03) | -724.00 | -0.32* (0.12) | 610 |
| Furniture | 8.33* (0.35) | 0.28* (0.02) | 0.88* (0.06) | -830.08 | -0.29* (0.14) | 420 | 9.61* (0.25) | 0.22* (0.02) | 0.77* (0.04) | -1131.41 | -0.40* (0.09) | 647 |

*Notes*: a) Ln K and ln L are natural logarithms of capital stock and labour respectively; b) Log L is the value of the log likelihood function, Rho is selection parameter; and N is the total number of firms; d) * indicates level of significance at 5 per cent; e) Figures in parenthesis are standard errors.

**Table 5a: Estimated production parameters, industry level, 1989-90 and 1994-95 (Informal Firms)**

| Industry | 1989-90 | | | | | | 1994-95 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Constant | Ln K | Ln L | Log L | Rho | N | Constant | Ln K | Ln L | Log L | Rho | N |
| Food | 7.66* (0.267) | 0.16* (0.01) | 0.21* (0.06) | -6301.2 | -0.27 (0.53) | 4146 | 6.67* (0.12) | 0.33* (0.01) | 0.54* (0.04) | -6791.8 | -0.27 (0.10) | 4993 |
| Tobacco | 8.65* (0.81) | 0.04 (0.035) | -0.13 (0.16) | -558.7 | 0.78* (0.12) | 386 | 9.1* (0.46) | 0.036 (0.026) | 0.007 (0.045) | -1570.9 | 0.55* (0.1) | 1063 |
| Textiles | 7.63* (0.25) | 0.17* (0.01) | 0.13* (0.05) | -5712.5 | 0.99* (0.05) | 4046 | 5.91* (0.06) | 0.34* (0.005) | 0.74* (0.02) | -8915.0 | 0.09 (0.08) | 8969 |
| Apparel | 7.13* (0.84) | 0.31* (0.07) | 0.28* (0.23) | -462.51 | -0.98 (10.65) | 283 | 8.47* (0.38) | 0.16* (0.04) | 0.84* (0.1) | -411.32 | 0.64 (0.88) | 371 |
| Leather | 7.78* (0.92) | 0.17* (0.04) | 0.25 (0.23) | -435.70 | -0.44 (1.30) | 292 | 6.98* (0.38) | 0.35* (0.03) | 0.77* (0.11) | -719.86 | -0.60* (0.25) | 551 |
| Wood | 7.94* (0.43) | 0.15* (0.02) | 0.35* (0.17) | -2009.27 | -0.05 (0.65) | 1323 | 7.98* (0.13) | 0.21* (0.01) | 0.73* (0.06) | -1853.07 | 0.36 (0.23) | 1639 |
| Paper | 9.51* (1.79) | -0.004 (0.8) | 0.90* (0.44) | -175.62 | -0.52 (0.83) | 113 | 6.09* (0.51) | 0.32* (0.05) | 0.95* (0.18) | -219.89 | 0.11 (0.38) | 171 |
| Publishing | 7.26* (0.69) | 0.18* (0.03) | 0.31* (0.19) | -1075.93 | 0.14 (1.12) | 708 | 7.29* (0.25) | 0.27* (0.02) | 0.74* (0.09) | -1074.20 | 0.12 (0.28) | 979 |
| Petroleum | - | - | - | - | - | 0 | 6.54* (1.25) | 0.32* (0.07) | 0.72 (0.48) | -70.01 | -0.12 (0.70) | 48 |
| Chemicals | 6.84* (1.30) | 0.22* (0.06) | 0.49 (0.40) | -411.48 | -0.28 (0.94) | 268 | 5.33* (0.44) | 0.44* (0.03) | 0.99* (0.16) | -937.06 | -0.57 (0.22) | 541 |
| Rubber | 8.14* (1.11) | 0.16* (0.05) | 0.61* (0.30) | -500.14 | -0.27 (1.13) | 308 | 6.50* (0.36) | 0.33* (0.03) | 0.83* (0.15) | -819.11 | 0.15 (0.35) | 566 |
| Minerals | 8.20* (0.64) | 0.11* (0.03) | 0.10 (0.22) | -850.93 | -0.003 (0.75) | 586 | 6.72* (0.18) | 0.35* (0.01) | 0.41* (0.06) | -2252.83 | 0.52* (0.11) | 1435 |
| Basic metal | 8.48* (1.90) | -0.01 (0.09) | 1.49* (0.68) | -288.10 | -0.39 (1.01) | 162 | 7.93* (0.49) | 0.20* (0.04) | 0.94* (0.29) | -377.65 | 0.13 (0.46) | 223 |
| Metal products | 7.19* (0.45) | 0.21* (0.02) | 0.43* (0.11) | -2383.10 | -0.04 (0.75) | 1565 | 7.18* (0.12) | 0.28* (0.01) | 0.82* (0.04) | -2819.40 | 0.18 (0.16) | 2546 |
| Machinery | 8.27* (0.43) | 0.15* (0.03) | 0.48* (0.18) | -1522.37 | -0.09 (0.82) | 1002 | 6.99* (0.18) | 0.28* (0.02) | 0.93* (0.07) | -1788.85 | 0.28 (0.18) | 1527 |
| Office machinery | 28.27 (18.93) | -1.42 (8.85) | -0.34 (8.44) | -15.36 | 0.86 (6.52) | 7 | 25.32 (32.73) | -0.96 (2.94) | 1.03 (7.96) | -15.22 | 0.68 (12.00) | 6 |
| Electrical machinery | 8.60* (0.91) | 0.16* (0.06) | 0.27 (0.36) | -309.33 | 0.001 (0.96) | 192 | 7.38* (0.36) | 0.24* (0.03) | 1.03* (0.15) | -426.28 | 0.09 (0.30) | 310 |
| Radio & Television | 11.30* (1.80) | 0.09* (0.13) | -1.18 (0.83) | -57.40 | 0.96 (0.85) | 35 | 5.35* (0.59) | 0.45* (0.05) | 0.94* (0.15) | -52.99 | -0.99* (0.15) | 39 |
| Medical, precision inst. | 10.49* (1.78) | 0.01 (0.14) | 0.99* (0.56) | -75.21 | -0.50 (3.96) | 56 | 6.28* (1.85) | 0.31* (0.12) | 1.01* (0.61) | -104.92 | 0.12 (0.73) | 69 |
| Motor vehicles | 9.37* (3.33) | 0.05 (0.31) | 0.96 (0.60) | -23.94 | -0.59 (4.14) | 22 | 6.06* (0.77) | 0.41* (0.06) | 0.79* (0.21) | -138.08 | -0.77 (0.73) | 98 |
| Transport equipment | 10.09* (0.53) | 0.12* (0.04) | 0.28* (0.20) | -213.43 | -1.00* (0.001) | 144 | 7.83* (0.63) | 0.23* (0.05) | 0.92* (0.21) | -447.88 | -0.01 (0.48) | 300 |
| Furniture | 6.90* (0.37) | 0.18* (0.02) | 0.59* (0.10) | -3554.82 | -0.22 (0.73) | 2358 | 7.85* (0.10) | 0.22* (0.10) | 0.79* (0.04) | -3194.97 | 0.17 (0.17) | 2992 |

*Note*: Shaded Industry is having very small number of informal firms; the estimates thus are not efficient. Hence the industry has not been considered for further analysis.
* Indicated level of significance at 5 per cent.

**Table 5b: Estimated production parameters, industry level, 2000-01 and 2005-06 (Informal Firms)**

| Industry | 2000-01 | | | | | | 2005-06 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Constant | Ln K | Ln L | Log L | Rho | N | Constant | Ln K | Ln L | Log L | Rho | N |
| Food | 6.61* (0.01) | 0.34* (0.01) | 0.74* (0.03) | -7842.5 | -0.46* (0.07) | 6188 | 4.19* (0.24) | 0.26* (0.01) | 1.27* (0.06) | -5097.98 | 0.08 (0.09) | 3475 |
| Tobacco | 7.22* (0.36) | 0.31* (0.03) | 0.18* (0.10) | -889.47 | 0.7* (0.18) | 538 | 3.99* (0.87) | 0.33* (0.07) | 0.78* (0.33) | -116.47 | -0.36 (0.64) | 87 |
| Textiles | 5.79* (0.13) | 0.37* (0.005) | 0.93* (0.02) | -6995.6 | -0.75* (0.03) | 7482 | 3.82* (0.26) | 0.33* (0.01) | 0.74* (0.05) | -1991.68 | 0.08 (0.15) | 1778 |
| Apparel | 7.07* (0.08) | 0.27* (0.01) | 0.96* (0.18) | -4435.96 | -0.86* (0.17) | 5582 | 3.97* (0.16) | 0.27* (0.01) | 0.94* (0.03) | -2437.32 | 0.45 (0.42) | 2954 |
| Leather | 8.07* (0.35) | 0.17* (0.02) | 0.85* (0.06) | -794.31 | -0.26 (0.17) | 807 | 4.18* (0.65) | 0.32* (0.04) | 0.85* (0.14) | -370.79 | -0.16 (0.24) | 312 |
| Wood | 8.05* (0.08) | 0.20* (0.01) | 0.82* (0.05) | -2390.10 | 0.25 (0.19) | 2638 | 5.69* (0.32) | 0.14* (0.02) | 1.09* (0.10) | -1311.09 | 0.13 (0.24) | 1144 |
| Paper | 6.55* (0.27) | 0.38* (0.02) | 0.43* (0.10) | -448.97 | -0.63* (0.20) | 389 | -0.51 (1.93) | 0.64* (0.12) | 1.65* (0.63) | -435.45 | -0.04 (0.39) | 195 |
| Publishing | 5.87* (0.17) | 0.35* (0.01) | 0.80* (0.05) | -1507.07 | -0.01 (0.19) | 1672 | 4.00* (0.58) | 0.24* (0.04) | 1.24* (0.14) | -979.56 | 0.14 (0.23) | 681 |
| Petroleum | 14.49* (2.96) | -0.38* (0.18) | 0.64 (0.89) | -90.43 | 0.50 (0.62) | 46 | 2.56 (2.91) | 0.42 (0.15) | 1.01 (0.92) | -104.88 | 0.54 (0.59) | 39 |
| Chemicals | 5.23* (0.37) | 0.49* (0.02) | 0.68* (0.16) | -1244.32 | -0.36 (0.27) | 691 | -0.10 (1.05) | 0.69* (0.05) | 0.85* (0.30) | -1328.28 | 0.18 (0.20) | 533 |
| Rubber | 6.59* (0.22) | 0.35* (0.02) | 0.78* (0.09) | -1035.66 | 0.09 (0.21) | 912 | 1.66* (1.07) | 0.46* (0.05) | 1.71* (0.33) | -1089.19 | -0.07 (0.23) | 511 |
| Minerals | 7.33* (0.13) | 0.32* (0.01) | 0.42* (0.05) | -3629.75 | 0.41* (0.11) | 2486 | 5.09* (0.47) | 0.25* (0.02) | 0.92* (0.13) | -4946.57 | -0.07 (0.15) | 1854 |
| Basic metal | 6.31* (0.27) | 0.35* (0.02) | 0.93* (0.12) | -568.39 | -0.35* (0.25) | 456 | 2.52* (1.30) | 0.37* (0.07) | 1.44* (0.47) | -630.86 | 0.16 (0.27) | 267 |
| Metal products | 7.76* (0.08) | 0.24* (0.01) | 0.79* (0.02) | -3437.30 | 0.38* (0.04) | 4184 | 4.25* (0.30) | 0.28* (0.02) | 1.07* (0.07) | -2629.71 | 0.14 (0.13) | 2019 |
| Machinery | 6.49* (0.18) | 0.31* (0.01) | 0.99* (0.06) | -1812.91 | -0.001 (0.15) | 1662 | 2.61* (0.74) | 0.35* (0.04) | 1.71* (0.18) | -1355.56 | 0.17 (0.16) | 745 |
| Office machinery | 5.37 (18.89) | 0.42 (1.86) | 1.51 (4.52) | -10.33 | -0.71 (13.19) | 11 | 16.96 (11.12) | -0.52 (0.95) | 2.05 (1.64) | -30.72 | 0.57 (4.87) | 14 |
| Electrical machinery | 6.44* (0.29) | 0.35* (0.03) | 0.98* (0.10) | -622.26 | -0.20 (0.28) | 524 | 3.02* (0.85) | 0.33* (0.04) | 1.97* (0.21) | -1140.86 | -0.11 (0.18) | 602 |
| Radio & Television | 3.15* (1.56) | 0.92* (0.14) | -0.57 (0.35) | -105.72 | 0.99* (0.001) | 56 | 3.31 (2.87) | 0.39 (0.25) | 2.82* (0.74) | -90.48 | -0.10 (1.13) | 40 |
| Medical, precision inst. | 8.57* (1.13) | 0.27* (0.10) | 0.38* (0.22) | -155.70 | -0.99* (0.08) | 120 | 1.33 (3.14) | 0.52* (0.14) | 1.61 (1.02) | -130.96 | -0.03 (0.74) | 65 |
| Motor vehicles | 6.62* (0.49) | 0.28* (0.03) | 1.08* (0.11) | -409.80 | -0.38 (0.24) | 358 | 3.91* (1.71) | 0.28* (0.08) | 1.53* (0.72) | -300.95 | -0.25 (0.55) | 150 |
| Transport equipment | 5.25* (0.66) | 0.46* (0.04) | 0.58* (0.17) | -330.74 | -0.63* (0.13) | 254 | 4.98* (1.64) | 0.23* (0.11) | 1.27* (0.47) | -338.44 | 0.12 (0.35) | 163 |
| Furniture | 7.72* (0.08) | 0.24* (0.01) | 0.80* (0.02) | -3732.66 | 0.45* (0.10) | 4624 | 5.27* (0.23) | 0.22* (0.01) | 0.91* (0.04) | -2763.44 | 0.09 (0.19) | 2581 |

*Note*: Shaded Industry is having very small number of informal firms; the estimates thus are not efficient. Hence the industry has not been considered for further analysis

* Indicates level of significance at 5 per cent.

**Table 6: Regression Results: Absolute and Relative Technical Efficiency**

| Variables | Absolute Technical Efficiency | | Relative Technical Efficiency | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Constant | 0.285*** (0.00220) | 0.347*** (0.00302) | 57.32*** (0.145) | 60.42*** (0.183) |
| Formal | 0.0597*** (0.00159) | 0.0408*** (0.00178) | -6.291*** (0.105) | -7.290*** (0.105) |
| Industry Fixed Effects? | No | Yes | No | Yes |
| Year Effects? | Yes | Yes | Yes | Yes |
| Number of observations | 169507 | 169507 | 169507 | 169507 |
| R-squared | 0.057 | 0.112 | 0.230 | 0.321 |

Note: *** indicates level of significance at 1 per cent. Figures in parenthesis are standard errors.

**Table 7: Are formal firms more efficient irrespective of their location (Rural and Urban)?**

| | (1) | (2) |
|---|---|---|
| VARIABLES | TE | RTE |
| FORMAL*RURAL | 0.164*** (0.00282) | -14.51*** (0.171) |
| FORMAL*URBAN | 0.138*** (0.00225) | -15.81*** (0.140) |
| Industry dummy | Yes | Yes |
| Year_1994 | 0.368*** (0.00280) | -40.67*** (0.157) |
| year_2000 | 0.228*** (0.00237) | -34.36*** (0.144) |
| Year_2005 | 0.0153*** (0.00253) | -10.87*** (0.174) |
| Constant | 0.261*** (0.00308) | 66.94*** (0.175) |
| Observations | 144825 | 144825 |
| R-squared | 0.202 | 0.434 |

Note: *** indicates level of significance at 1 per cent. Figures in parenthesis are standard errors.

**Figure 1a: TE differentials between Informal and Formal firms**

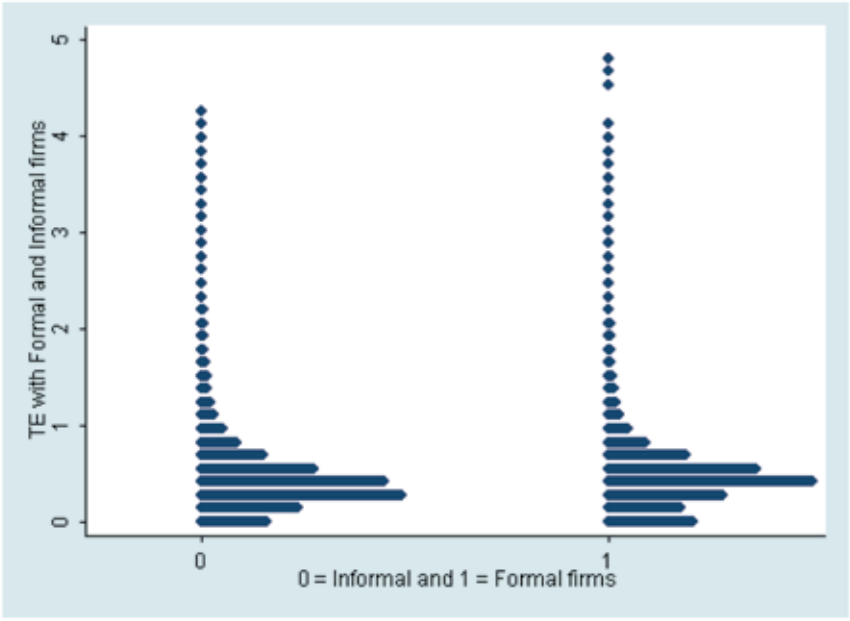


**Figure 1b: Relative TE differentials between Informal and Formal firms**

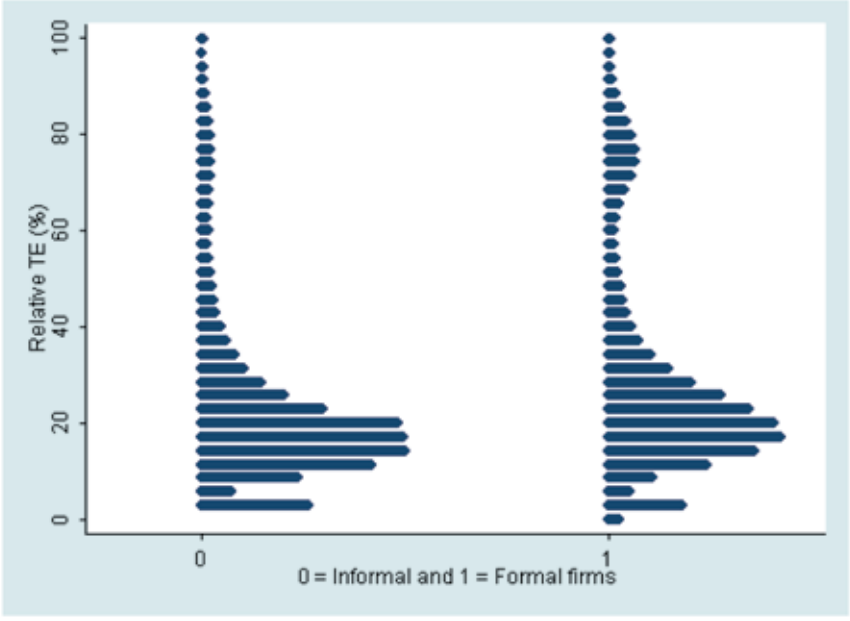

**Figure 2: Location-wise comparison TE of formal and informal firms**